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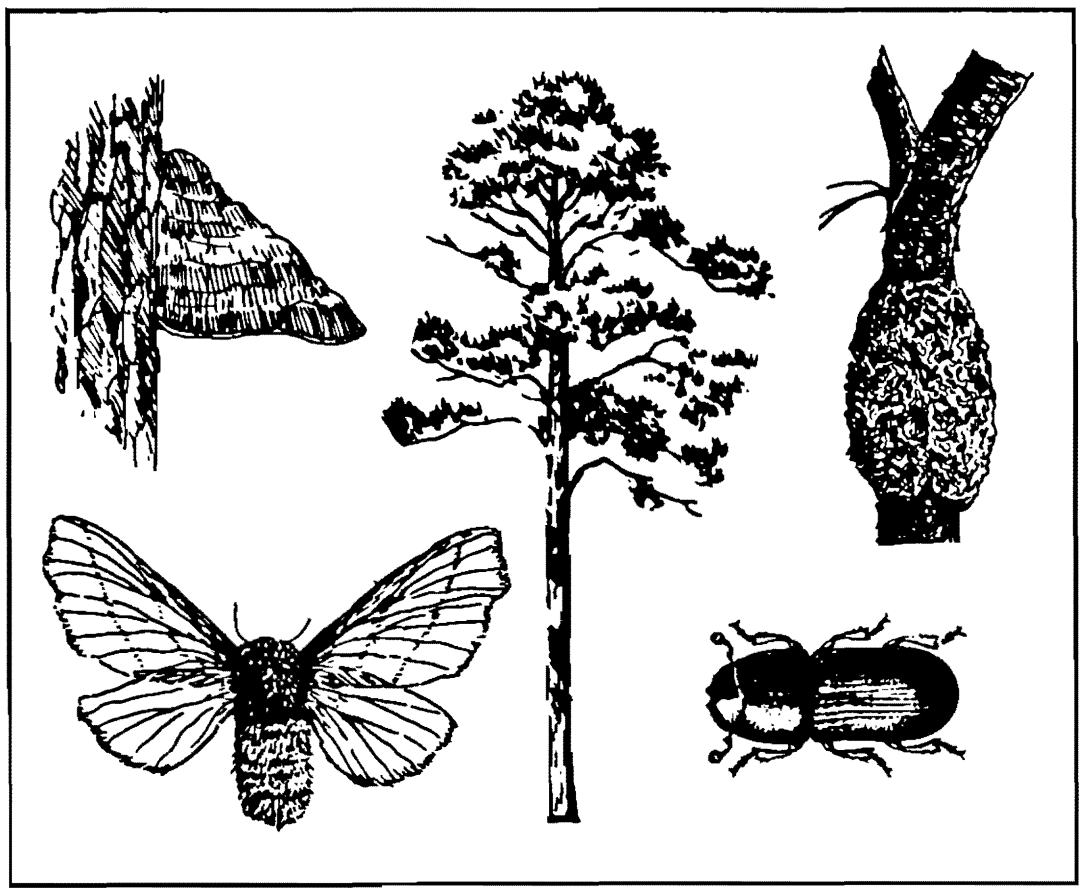

SURVEY AND EVALUATION OF PITCH CANKER IN A SHORTLEAF PINE SEED ORCHARD, NORRIS, TENNESSEE - 1983

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ABSTRACT

An 18-year-old shortleaf pine seed orchard was severely damaged by an outbreak of pitch canker estimated to have occurred from 1980 to 1983. A survey of all ramets showed only 1 percent were disease-free, and 37 percent had more than a quarter of their live crown killed by disease. Of 37 clones in the orchard, 10 were judged relatively susceptible and 5 relatively resistant.

INTRODUCTION

Severe pitch canker was detected in an 18-year-old shortleaf pine seed orchard located in eastern Tennessee during an inventory in the spring of 1983. Most of the trees in the orchard were infected, with many trees losing much of the top half of the crown. The impact of the disease on cone production in diseased trees was obvious, because most of the cones are produced in the damaged area.

Pitch canker, a shoot-killing disease affecting all of the southern pines, is caused by a fungus (Fusarium moniliforme var. subglutinans), and has been serious in slash pine plantations in Florida. Cones may be infected, and stem cankers occasionally occur. It is a wound parasite and can be insect vectored (Blakeslee, et al., 1980). Several thousand acres of 15- to 20-year-old slash pine were harvested in salvage operations in Florida during a 1975-80 epidemic. In Tennessee, a 73 acre shortleaf stand, severely damaged by pitch canker, was prematurely harvested in 1976. This stand was located about 35 miles from the seed orchard.

Seed orchards have experienced periodically damaging pitch canker (Table 1), and all investigators of pitch canker in seed orchards have reported the disease to be clonal. Reduction in cone and seed yield would seem inevitable during severe episodes. Cone harvest in a Mississippi loblolly orchard one year after severe pitch canker was only 13 percent of the previous year's crop (Dwinnell, et al., 1977). Some of this was likely due to factors other than pitch canker, but the disease had considerable influence. In contrast to the cone yield reduction in the Mississippi orchard, abundant disease in a North

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Table 1.--States with reports of damaging pitch canker in seed orchards of different southern pine species, 1983.

State	Species	Reported by
Alabama	shortleaf	Kelly, 1982
	loblolly	Kelly, 1982
	Virginia	Miller, et al., 1980
Florida	slash	Phelps & Chellman, 1976
Georgia	loblolly	Kauffman (personal communication from R. Wilson)
Mississippi	loblolly	Dwinnell, et al., 1977
	slash	Miller, et al., 1980
North Carolina	loblolly	Kuhlman, et al., 1982
	longleaf	Oak (personal communication from C. Doggett)

Carolina loblolly orchard did not prevent record cone and seed crops during or one year after the outbreak (Kuhlman, 1982). The pattern and severity of disease within a tree can be variable and determines the impact on cone yield.

A survey and evaluation of the Tennessee Division of Forestry shortleaf pine seed orchard was needed to determine;

1. the incidence of pitch canker in the orchard,
2. distribution patterns of pitch canker in the orchard,
3. the severity of pitch canker in different clones,
4. clones with potential for resistance breeding, and
5. if disease levels will permit continued management after applying therapeutic pruning and rogueing of susceptible clones.

METHODS

Three elements are needed to characterize pitch canker infection in a tree. These are the time of shoot mortality (current year or previous years), the type of branch infected (terminal and/or lateral), and the amount of the crown killed.

Shoots killed in the current year have red or brown foliage, while those killed in previous years have no needles or have grey needles adhering.

Terminal and/or lateral infection was rated according to the year of infection. When terminal infection occurred in a previous year or years, the shoot exhibiting apical dominance was identified as the terminal and rated for current disease. Occasionally, no apical dominance was expressed, and no terminal infection could be rated for the current year.

Crown mortality was estimated according to the following categories:

a. healthy
b. trace of disease
c. trace to 25 percent
d. 26 to 50 percent
e. greater than 50 percent
f. dead, pitch canker
g. dead, other

Two observers simultaneously rated the same tree crown at about a 90-120° angle from each other in order to view most of the tree crown. A crown's rating was determined by mutual agreement. Observations are most accurately made on clear days, with the sun to the back of the observers to minimize glare. These conditions prevailed on the date of the survey.

Ranking clones for relative resistance was done on the basis of the proportion of ramets in different categories of crown mortality. A minimum of five ramets were needed to rank a clone. Resistance rankings were:

relative resistant - $a + b \geq c + d$ and $e + f = 0$

intermediate resistance/susceptibility - $a + b + c > d + e + f$

relatively susceptible - $a = 0$ and $b + c \leq d + e + f$

uncertain - less than five ramets available for ranking

RESULTS AND DISCUSSION

Pitch canker damaged all but 5 ramets of the 344 present (98.6 percent of total), with nearly half in the trace to 25 percent crown damage class. More than one-third (37 percent) were severely damaged (more than 25 percent of crown killed, [Figure 1]).

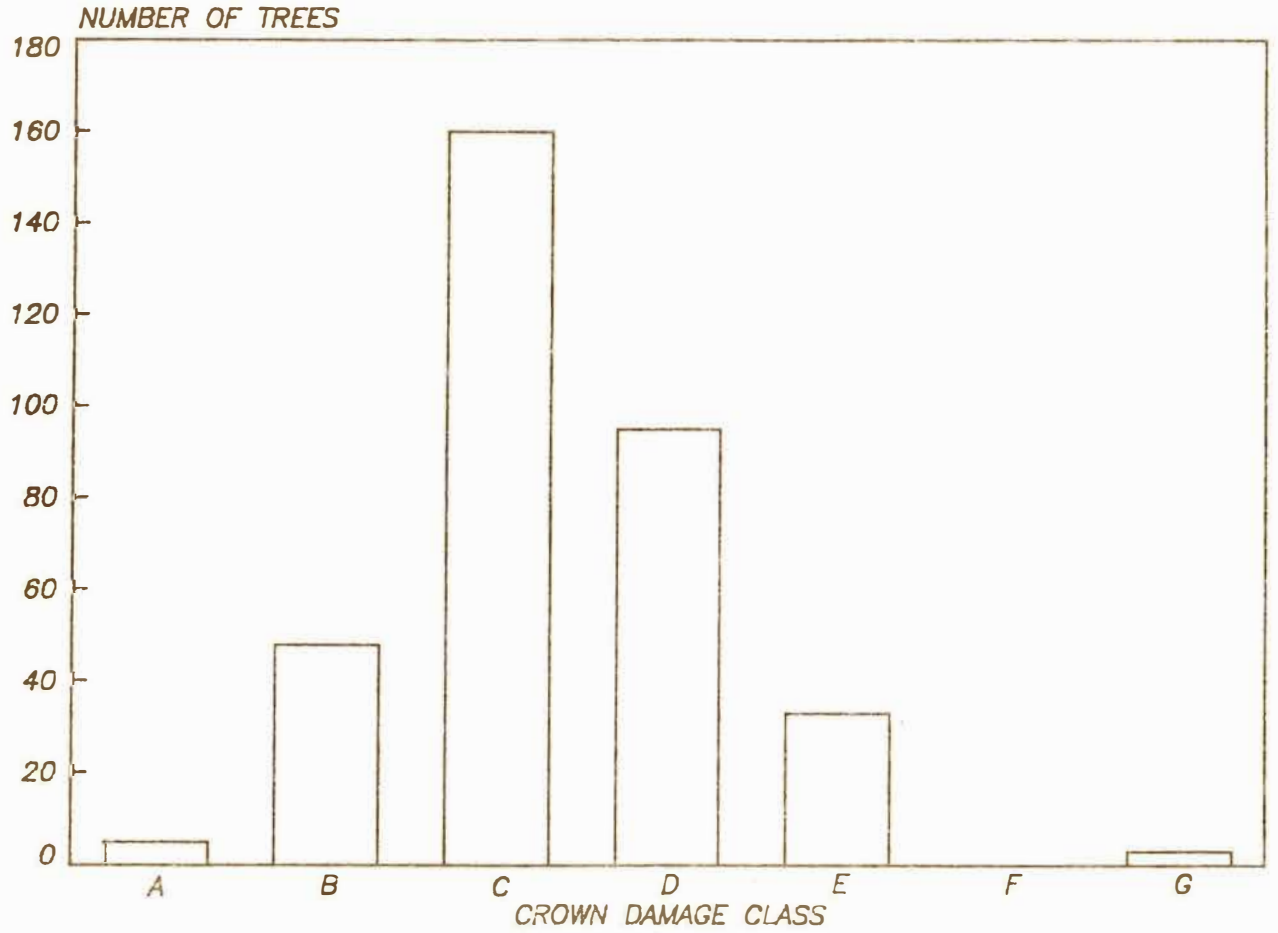
The disease seemed to have first appeared at noticeable levels during 1980. Substantial infection occurred between 1980 and the survey. Most diseased ramets were damaged in both previous and current years. There were more trees with current damage than previous years, suggesting the disease is still intensifying. However, most current damage is slight (one to several shoot tips), and we judge the epidemic to be abating. This could be due to a combination of the absence of one or more unknown biological and environmental factors (e.g., insect vectors, host tissue conditions, soil moisture, and soil fertility) influencing tree susceptibility to pitch canker infection and less susceptible tissue available for infection due to substantial crown dieback.

Spacial distribution patterns of pitch canker are difficult to discern. Disease is so abundant and severe, that no contiguous areas of healthy trees exist. Plotting heavily diseased ramets shows at least one area of concentrated, severe damage (Figure 2). In the outlined portion, 28 of 35 ramets (80 percent) are heavily damaged.

Clonal variation in disease susceptibility was evidenced during this outbreak. Five clones express fairly consistant relative disease resistance, with 10 showing equally consistent relative disease susceptibility. An additional 16 clones have intermediate rankings, with the remaining 6 clones having uncertain rankings because of too few observations (Table 2).

The area of concentrated, severe damage described earlier (ref. Figure 2) may have been a result of a concentration of relatively susceptible clones. Of the 28 severely damaged ramets, 15 are of clones in the susceptible ranking. Further, 86 percent of the most severely damaged (class e) ramets in this area are of relatively susceptible clones. The disease may have begun early in the relatively susceptible clones, intensified, and then spread to nearby trees.

FIGURE 1. Frequency distribution of trees of a pitch canker-infected shortleaf pine seed orchard in various crown damage classes. Norris, TN, 1983.



(A=HEALTHY; B=TRACE; C=TRACE-25%; D=26-50%; E=>50%; F=DEAD PC; G=DEAD OTHER)

Figure 2. Map of a shortleaf pine seed orchard, Norris, TN, showing the location of ramets and the distribution of ramets with severe pitch canker (more than 25 percent of live crown killed) 1983.
X=Ramets with less than 25 percent of crown killed; 0=Ramets with more than 25 percent of crown killed (severly diseased).

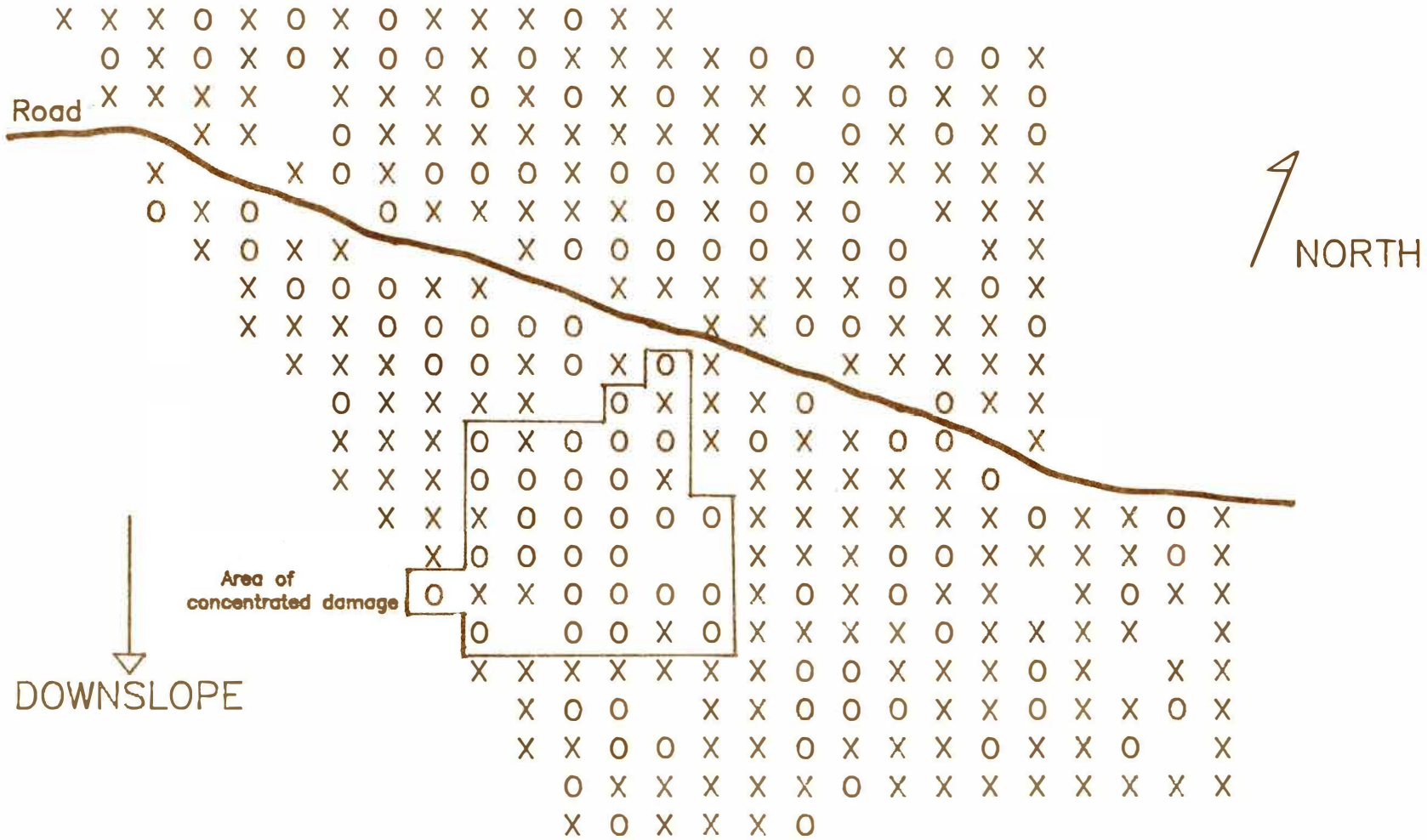


Table 2.--Distribution of damage classes and relative ranking[1/] of pitch canker resistance for clones present in a shortleaf pine seed orchard, Norris, TN, 1983.

Ranking	Clone	Crown Damage Class[2/] (number of ramets) a	b	c	d	e	f	g	Total
Relatively Resistant 1/	20	1	6	4					11
	18	1	5	4	1				11
	27	1	8	3					12
	37	1	7	1					9
	23		3	2					5
Intermediate Resistance 1/	15		4	12					16
	24		1	5					6
	22		2	8	1				11
	68		3	7	2			1	13
	00		2	5	3				10
	76		2	6	4				12
	97		1	10	2				13
	21			10	3				13
	12			10	4				14
	28			7	4				11
	98			7	4			1	12
	16			12		1			13
	69		1	7	4	1			13
	71		1	6	5	1			13
	61			6	5				11
	62			3	1	1			5
Relatively Susceptible 1/	29			6	6				12
	86			1	5	4			10
	96			1	4				5
	59			2	2	2		1	7
	25				2	6			8
	19			7	7				14
	26				7	8			15
	31			1	7	1			9
	30			3	5	4			12
	60		1	2	4	1			8
Uncertain	33			1	1				2
	32	1	1						2
	80				1	2			3
	63					1			1
	10				1				1
	17			1					1
Total	37	5	48	160	95	33		3	344

1/ Rankings not continuous within or between a given resistance group.

2/ a = healthy; b = trace; c = trace - 25%; d = 26-50%; e = >50%; f = dead PC; g = dead other.

MANAGEMENT RECOMMENDATIONS

Strategies for managing losses caused by pitch canker in seed orchards include rogueing susceptible clones, and minimizing wounding from various sources (cone harvesting, tree shakers, mowers), especially from July to November when spore dispersal is at its peak (Blakeslee, et. al., 1980). Further, therapeutic pruning during the low inoculum dispersal period may be desirable to promote rapid canker healing, improve tree form, and eliminate inoculum produced on killed branches.

A return to normal seed orchard management (insect control, fertilization, and mowing) could have both positive and negative influence on the probability of future disease outbreaks. Insect vectors (deodar weevils) and wounding agents (tip moths) may be controlled, lessening the available inoculation sites. However, there are reports that indicate fertilization of diseased trees may result in increased pitch canker damage (Fisher, et al., 1981).

Some factors determining whether to re-initiate management of the Norris shortleaf pine seed orchard include;

1. the value of this source of shortleaf pine seed,

2. the cost and availability of alternate sources,

3. the cost of recommended rogueing and pruning and potential effectiveness, and

4. the costs associated with re-establishing desirable clones in another location.

Our observations indicate the disease is declining. We conclude that rogueing clones judged susceptible by the criteria used herein or by other standards, and properly timed pruning, would leave enough cone-producing orchard to justify re-initiation of management, if the value of this source of seed is sufficiently greater than the value of alternative seed sources.

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